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TSUNAMI NEWSLETTER is published by the International Tsunami Information Center to bring news and information to scientists, engineers, educators, community protection agencies and governments throughout the world.

We welcome contributions from our readers.

The International Tsunami Information Center is maintained by the U.S. National Oceanic and Atmospheric Administration for the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization. The Center's mission is to mitigate the effects of tsunamis throughout the Pacific.

MEMBER STATES

Present membership of the International Coordination Group for the Tsunami Warning System in the Pacific comprises of the following States:

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CHILE
CHINA
COLOMBIA
COOK ISLANDS
ECUADOR
FIJI
FRANCE
GUATEMALA
INDONESIA
JAPAN
KOREA (REPUBLIC OF)
MEXICO
NEW ZEALAND
PERU
PHILIPPINES
SINGAPORE
THAILAND
UNITED KINGDOM (HONG KONG)
USA
USSR
WESTERN SAMOA

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FEATURE

Automation Highlights of the Pacific and Alaska Tsunami Warning Centers

By Thomas J. Sokolowski (March 21, 1983)

(The following is a continuation of the paper presented in our last issue of the Tsunami Newsletter, May 1983, Volume XVI, No. 1)

ALASKA TSUNAMI WARNING CENTER

Before entering into the ATWC automation, I will discuss the ATWC functions, past manual operational procedures, etc., to show which manual methods could be automated from a bases of manual operational methods.

The ATWC was born in 1967 as a result of the 1964 earthquake in the Prince William Sound area. It's geographical location is such that most major seismic zones are at favorable "P wave travel time" distances. Seismic data from the large ATWC array results in good earthquake locations for performing the TWS services. The Center is operated on an inverted battery power supply which is backed up by an automatic startup propane generator. This power system ensures available seismic data for earthquake/tsunami investigations.

MISSION

The primary mission of the ATWC is detecting and locating major earthquakes, and if they are tsunamigenic, providing tsunami watches and warnings for Alaska, California, Oregon, Washington, and British Columbia in Canada. This service is provided on a 24-hour basis for each day of the year.

To perform the primary mission, the ATWC duty personnel are notified of the occurrence of a large earthquake by an alarm-radio system attached to four alarms connected to incoming real-time seismic data. Earthquakes that activate the ATWC alarm system initiate an earthquake/tsunami investigation which includes the following three basic steps: locating and sizing the earthquake; obtaining tide gage data from tide sites along the U.S. West Coast, British Columbia, and Alaska, to verify the existence of a tsunami; and disseminating the earthquake/tsunami information to recipients participating in the TWS when tsunami watch or warning criteria are met. Smaller earthquakes, which are important to Alaska, are processed on a routine basis and the information disseminated to the news media, Alaska Division of Emergency Services, radio and television, and the Alaska Air Command.

A secondary mission is the routine collecting, processing, and archiving and transmitting data to National Earthquake Information Service (NEIS), USGS at Menlo Park, University of Alaska, and the Geoscience Center in Canada.

THE ATWC REAL-TIME SEISMIC AND TIDE NETWORKS

The ATWC's real-time network is one of the largest geophysical data acquisition networks in the world, utilizing approximately 8,400 terrestrial miles of dedicated leased data circuits to record approximately 150 analog data traces in one common location. There is very little interruption of data flow from the remote sites which are visited each year, and as soon as possible following an equipment failure for emergency service.

MANUAL TWS OPERATIONAL PROCEDURES

The manual methods to locate and size an earthquake requires the duty personnel to measure many onset times of P waves, recorded on helicorders, develocorders and magnetic tape. Local epicenters are determined by a time difference of P wave arrivals between the ATWC (as reference) and other selected Alaskan stations. Computer prepared "P - time differences" for normal depths have been contoured on Lambert projection maps of Alaska. Immediate P times of earthquakes are obtained from helicorders and develocorders, or from the dynagraph magnetic tape playback system, which is activated by the seismic alarm. Local magnitudes (ML) are calculated from periods and amplitudes obtained from several short period systems. Manually determined epicenters, for teleseismic earthquakes, also use a method of time difference of P wave arrivals. Usually on teleseismic events, the times are read from a develocorder. A "time difference" book has been developed and the seismic geographic areas sorted into numerical blocks, and listed in order by distance and azimuth from Palmer. This book utilizes computer prepared P time differences from Palmer to all Alaskan stations, plus Honolulu, Guam, and others. The magnitude for teleseismic events are usually determined from Shemya, Palmer, Golden, and Newport long period data.

The manual methods for producing teletypewriter messages were similar to those used by the PTWC prior to message automation.

This is a good manual system, and to improve it further, required an on-site computer.

MANUAL-COMPUTER TWS OPERATIONAL PROCEDURES

In October 1979, a Data General (DG) S230 computer and peripherals were installed in the ATWC. The major peripherals included a magnetic tape unit, 10 MB disk, Dasher line printer, CRT's, and Genisco graphics terminal. Art Tanimura installed the DG RDOS operating system software and the PTWC applications software.

The PTWC application programs were modified by the ATWC personnel, reflecting the operational differences between the two centers. The ATWC is basically a data center and the PTWC, a communications center. This major difference necessitated numerous changes in both the message composing software and the earthquake parametric data calculating software. Some software and logic modifications included: manual data entry into

the computer; magnitude (ML and Mb) computations; dissemination point addressees; message structure; and various other input and output routines and files. Also, similar earthquake location and message generating schemes were programmed for the backup GE time-share system. This work was implemented between 1979 and 1981.

The introduction of the computer enhanced the TWS procedures by: increasing earthquake location accuracy; permitting more results (depth, magnitude, etc.) to be computed rapidly, thus giving more information about the earthquake; and, preparing teletype messages easily and in a timely fashion. However, it did not reduce the data collecting work during an earthquake/tsunami investigation, nor did it reduce the work involved in performing the secondary ATWC function.

Given below, are some manual-computer operational procedures to aid in determining what can be automated, their benefits, and their priorities for automation. Interjected are comments concerning the automation of some manual operational parts.

1. The ATWC alarm-radio system alerts the principal duty personnel (DM) and assistant (DM) and they arrive (or are) at the office.

2. The DM uses a ruler to measure the time (hr,mn,sec) of the onset of the P phases, recorded on helicorder(s) and develocorder(s). As the principal DM moves from helicorder to helicorder, he voices the measured P time and seismic site which recorded the event. These data are heard by the assistant DM who transcribes them on a sheet of paper.

3. The DM goes to the computer (helicorders are 20 feet and the develocorders are 30 feet from the computer) and manually enters the P times into the computer using a CRT console. Interactively, an earthquake location is calculated and parametric data (latitude, longitude, magnitude, P times, etc.) are displayed on a CRT and a line printer. The computational results and data are visually scanned to verify the accuracy of the epicenter and the P times used to determine that epicenter. Manual data gathering makes it necessary for the DM to go back and forth between the helicorders and/or develocorders, and the computer. Some common reasons for going back and forth are: errors occurring during the initial gathering of P times; errors occurring in transcribing the P times; more data are required for azimuthal control around the earthquake; or the DM has difficulty in getting a suitable location and wishes to recheck data.

4. After the earthquake is located, the DM returns to the helicorder(s) and/or develocorder(s) to measure particular wave periods and amplitudes, from other seismic wave groups, for determining the magnitude of the earthquake. These data are obtained from various seismic sites to calculate a magnitude for each of those sites.

5. The DM returns to the computer and enters these data interactively to calculate a representative magnitude (Mb, ML, MS) for the earthquake.

6. Depending on the earthquake's location and size, various ATWC earthquake/tsunami procedures are implemented for disseminating earthquake/tsunami data and information messages to the TWS recipients.

7. If a large earthquake is outside the ATWC area of responsibility, the raw seismic and refined earthquake parametric data are immediately transmitted to PTWC, NEIS, and others.

Almost all of the time required to arrive at the magnitude determination point, i.e. to issue or not issue a warning, is used to collect data (Wave P times, periods, and amplitudes). Some immediate benefits in automating these manual methods would be to: reduce manual data collection and data transcribing, thus permitting more time for decisions rather than data collection; increase data collection accuracy in P times, periods, and amplitudes; compute magnitudes for many sites rather than a few; standardize computational methods, procedures, and timeliness; centralize data acquisition, analysis, and information dissemination equipment; and, transmit raw seismic and refined earthquake parametric data to users, in a timely manner, since the data and computed results would be stored on disk ready for dissemination.

Given below are some daily routine processing procedures viewed for automation.

1. A high gain helicorder record is scanned for any recorded local (ML>=3.0) and teleseismic earthquakes. The develocorder film which records one day of data is used in conjunction with an enlarger, to search serially for these earthquakes. Once the earthquake is found, P phase times, periods, and amplitudes are measured with a ruler and transcribed on a data log. Serial scanning then continues. P phases could be recorded from as many as 20 different seismic sites depending on the size of the earthquake.

2. After these data are measured and transcribed for each earthquake, and if there are 5 or more P times for each earthquake, the P's, amplitudes, and periods, are entered into the computer using a CRT console, to determine the earthquake location, size, and to detect data gathering and transcribing errors.

3. A teletype data message is prepared manually and sent to NEIS.

The above routine processes involve repeated transcribing and/or typing the same data. The time to complete those processes depends on the number of earthquakes that occur each day and could take many hours. Automation of these manual methods would reduce the time and work involved in routine collecting, processing, and transmitting earthquake data.

THE ATWC REAL-TIME ON-LINE AUTOMATION

During the summer of 1981, a concerted automation direction was established towards on-line real-time earthquake data processing. The RDOS operating software was determined to have the highest probability of success in

processing earthquakes automatically in real-time and on-line. There were differing views held by both the ATWC and the PTWC concerning the DG operating system. (The AOS is a superior system for message composition and automatic dissemination, while RDOS is a superior system for processing real-time data from numerous sources. Thus, the differing views were merely a reflection of the vastly different requirements of the two centers.) The PTWC wanted to use AOS and the ATWC wanted to use RDOS. This was resolved during the October 1981 Tsunami Coordination Meeting held in Anchorage. It was conceded that the ATWC and the PTWC would pursue the automation goals with their respective operating systems, and upon accomplishing goals, would give the development to the other Center for their implementation.

A general ATWC automation plan was developed to determine direction and goals to be achieved. Since this real-time project was a first of its kind for such a large seismic network, flexibility was incorporated so that goals could be achieved by alternate routes. Interim progress reviews were established to monitor progress and determine problem areas.

The first step in the plan was the data acquisition and analog to digital (A-D) data conversion. The interface wiring and testing for the DC/DAC hardware data acquisition system was completed during the summer of 1981 in preparation for accepting real-time seismic data into the computer. The DG Sensory Access Manager (SAM), which is supported by RDOS, was used for data acquisition and A-D conversions. The intended development required multi-tasking and almost immediately, problems were encountered. These problems were overcome by software consultations with a DG System Engineer.

Several multi-tasking routines were developed and implemented to read the real-time clock and to create buffers for accepting on-line real-time seismic site data. Temporary hardware modifications were performed to control and verify input data accuracy by displaying the computer accepted data signals on a line printer. This part of automation was completed in the fall of 1981 with 32 seismic data channels being accepted and digitized by the computer.

Concurrent with the data acquisition and A-D conversion, a survey was being conducted to identify which organizations were processing (P-picking, epicenter locations, etc.) seismic data on-line and in real-time, and whether their software or developed techniques could be applied to the ATWC automation project. The ATWC wanted to take advantage of complete or partially developed software and/or methods, that would execute on our computer, to advance our efforts. The survey showed that there were about 8 to 10 different individuals, agencies, etc. that were involved with automating real-time earthquake data. They were in different stages of development and only three had a working on-line real-time system. These three, University of Washington, Kinemetrics Inc., and UCLA were automatically processing earthquake data for a small network of seismic stations. Their processing computer was different from the ATWC DG computer. This means that simple software conversions to our DG system were not possible and techniques would have to be developed to automate our large seismic network for the DG system.

An attempt was made to convert borrowed software to our DG system and was futile, due to machine differences, lack of software documentation, and lack of understanding the DG's system internals. Efforts continued in evaluating the "state of the art" methods for event detection and seeking systems help.

The ATWC borrowed and tested a "blackbox" type microprocessor event detector which was produced by Geotech, Inc. during the latter part of 1981. The testing showed that the event detecting algorithm determined P wave arrival times (P-picks) well and was applicable to our automation efforts. The algorithm and event determining procedures were obtained from a paper by Veith and Sherwin, 1977. The algorithm was programmed as a multi-tasking module and the ATWC P-picking attempts started (and so did our problems) in November 1981.

In January 1982, software consultations were again held with a DG System Engineer concerning the ATWC P-picking software efficiency. The structure of our software routines would not permit the CPU to have enough time to accept and process any of the desired 32 channels of real-time digitized data. In April - May, we were able to process a single channel of seismic data and then advanced to a maximum of 5 channels with more software consultations with DG systems personnel.

In May, Sokolowski visited the University of Washington, the USGS at Menlo Park, and Sierra Geophysics Inc. to consult with, seek help, and review their on-line real-time data processing accomplishments. Sierra Geophysics was willing to sell the ATWC a $350K real-time on-line earthquake processing system, which was not guaranteed to work for the ATWC net, nor did it include the cost for a pre-site study. The USGS Research Center at Menlo Park was in the process of converting (C. Johnsons, UCLA) software to their Digital Electronics Corporation (DEC) computer. It was interesting to note that the USGS originally intended to use DG computers (like our Eclipse system) for real-time earthquake processing, but then switched to the DEC computer. It should also be mentioned that the on-line real-time systems that I reviewed cost about $350K. The total current ATWC computer and equipment is about $130K.

During the summer of 1982, an Anchorage software systems group, Van Amburg Inc., was consulted to aid the ATWC's efforts to process more channels of data. This led to processing 16 channels of seismic data. Having achieved the ability to process more data channels, the earthquake location scheme was integrated with the existing multi-tasking routines to produce our first acceptable real-time automatically located earthquake. We still lacked a key component of the project, i.e. to store digitized event data, from various seismic sites, for later graphics applications and other future development.

During this same period, Geotech Inc. published a paper on their new real-time on-line earthquake processing system. The basic system cost was less than any of the other systems that were visited. A Geotech representative was invited to visit the ATWC to review our problem areas and suggest solutions. Like the others, their earthquake processing

system used a DEC computer. The Geotech representative visited the ATWC in October and viewed our on-line real-time automation development. Discussions centered on a "front end" to process real-time events, store their associated wave form data, and have all of this available to a "mainframe" computer. At a later date, Geotech contacted the ATWC and proposed selling us their software for $25K, which was written for their DEC machine, for us to convert to our DG system. This was not acceptable (we've already tried that with free software) but a purchase of a future DEC "front end" option was left open.

During the last quarter of 1982, the Alaska Regional Director approved a request for a part time DG systems specialist to work at the ATWC. The ATWC now had the three necessary key types of personnel to further the automation project, i.e. hardware personnel to perform temporary and permanent hardware modifications for testing and implementing the progressing development; a systems person to produce software and integrate concepts and piecemeal parts into a whole working unit; and, application personnel to further develop techniques for specific parts of the TWS selected for automation.

The automation plan was modified with the development being divided into two stages. The first stage was to continue developing and programming the various concepts, and to integrate them with the computer and peripherals to form a whole automatic working unit in real-time and on-line, i.e. 1) locating and sizing events; 2) storing digitized seismic wave data and earthquake parametric data; 3) displaying the digitized wave data on a graphics terminal and the parametric data on a CRT and line printer, for an operator to review and perform epicenter recomputations, if necessary; 4) continually monitoring and processing real-time seismic data in the foreground, and concurrently, using the CPU background for routine processing, techniques development, etc., without interferring with real-time on-going processes.

The purposes of this "whole unit" concept were to determine: problem areas which would not surface while developing and implementing an individual part of the whole; the capability of the ATWC equipment and peripherals to perform as we expected them to perform; and, if the original concepts would work as planned.

The second stage involved improving parts of the first stage's software and hardware as technology advanced and improved equipment became available. This stage would permit us to: further determine the extent to which the individual pieces of equipment could be used; determine other required equipment; and, bring us to the "state of the art" in all parts of the automation project.

At the end of the first quarter of 1983, the first stage of our automation efforts were accomplished, i.e. we have a working on-line real-time earthquake processing system which is ready for the refinement stage. This configuration is not a finished product but it is working as a unit.

The following earthquake processes are done automatically:

1. Thirty-two channels of real-time seismic data, from sites in Alaska and the lower 48, are continually being monitored by the computer for the occurrence of an event.

2. Once an event is detected on a channel, the P-pick time is determined and stored along with pre-event and event digitized data. A five minute window interval is then established for collecting, processing, and storing P-picks and associated wave form data from all sites which recorded the event.

3. If five P-picks are obtained prior to the termination of the five minute window interval, an automatic earthquake location is calculated and displayed on a line printer, using the first five P-picks without interfering with the on-going processes.

4. At the end of the five minute interval, up to 32 digitized seismic wave form traces can be displayed together on a graphics terminal and stored on the disk. Each trace is preceeded by 23 seconds of pre-event and 23 seconds of event data. Superimposed upon each trace is an arrow indicator showing the computer determined P-pick.

5. Immediately after the digitized wave form data are displayed on the graphics terminal, the earthquake parameters of latitude, longitude, magnitude, depth, etc., are calculated using all data collected during the five minute interval. These results are displayed on a CRT and a line printer and can easily be refined.

Many earthquakes have been located automatically with some using as many as 22 P-picks from a possible 32. Some typical locations are Alaska, Japan, U.S. West Coast, Kermadec Is. (near New Zealand), New Hebrides, Philippines, Peru, Mexico, Russia, and Greece.

Many of the earthquake locations contain some erroneous P-picks. The most common P-pick errors are due to: the P wave is masked in the background and later waves are above background noise, resulting in the later phases being automatically determined as P waves; and, due to the size of our net, multiple earthquakes could occur about the same time, in different regions, thus mixing different earthquake P waves. The erroneous P-picks, due to masking, can easily be eliminated from the final earthquake computation. The erroneous P-picks, due to multiple events, will be addressed during the refinement stage.

The automatically calculated magnitudes (ML & Mb) will also be addressed in the refinement stage, due to a large variation in the individual magnitudes calculated from each of the various sites for the same event.

NEAR FUTURE HIGHLIGHTS

During the past several months, we have made considerable progress in obtaining a whole working system for automatically locating moderate

and major earthquakes. We have also proved that the initial automation concepts do work and that the DG computer can perform the intended conceptual tasks. The present automation system has parts that work well and some parts which will be improved during the refinement stage. Furthermore, parts of the present system are fragmented and require consolidation before intense refinement can begin.

Concurrently with consolidation and techniques refinement, we will integrate the use of the "joy stick" to modify data displayed on the graphics terminal and stored on the disk.

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NEWS EVENTS

Earthquake in the Indian Ocean

A strong earthquake, measuring 7.6 in the Richter Scale, occurred at 5.5 S and 72.0 E, 100 miles north of Diego Garcia on November 30, 1983 at 1746 Z. No major damage was reported. A rise of 5 feet in the water level of the lagoon of Diego Garcia island was reported. No details are available.

It was also reported that the waves observed in the lagoon of Diego Garcia were a series of waves which began 30-35 minutes after the earthquake. At 2216 Z, four and a half hours after the earthquake, a 40 cm drop was observed at Victoria in the Seychelles islands at high tide. Six hours later at approximately 0400 Z at low tide the sea level was 12 cm above normal. The quake epicenter was near the boundary of the Carlsberg Ridge and the Chagos plateau. According to NEIS only an earthquake of approximately 7 on the Richter scale has occurred in the vicinity previously in the last decade. ITIC is continuing its investigation of this event and may report further if additional information becomes available.

Large Earthquake in Hawaii, 16 November 1983

A major earthquake, measuring 6.7 on the Richter scale, occurred on the island of Hawaii at 0613 (local time), in the Hawaiian islands. The earthquake's epicenter was at 19.4 N, 155.5 W in the vicinity of the Mauna Loa Volcano and was shallow in depth (approx. 7 km). The quake caused considerable damage to property ($5.5 million), roads and bridges, but did not cause any fatalities. Only six persons were reported as injured.

Earthquake in Chile

A strong earthquake, measuring 7.4 on the Richter scale, jolted northern Chile at 1852 Z on 4 October 1983. The quake was located near 25.9 S latitude and 70.0 W longitude, south of Antofagasta. Five people were killed and at least 12 people reported injured. About 40 homes were either destroyed or damaged. The quake was felt as far away as Sao Paulo, Brazil and caused buildings to sway. A 150 cm drop in sea level was reported at Chanaral, Chile, near the epicenter. This might have been caused by the uplift of the land. A 10 cm to 20 cm change of water level was reported at Valparaiso at 2040 Z, 2120 Z and 2150 Z. No report of tsunami is reported from Talcahuano, Antofagasta and Arica.

Earthquake off the Solomon Islands

An earthquake, located at 7.5°S and 156.5°E, off the Solomon Islands, occurred on 15 October 1983. The magnitude of the quake was 6.7. No tsunami was generated. A report dated 31 October 1983 from the Chief Geologist of the Solomon Islands stated that several houses constructed with local materials were damaged on the island of Ranongga but there were no casualties reported. Details of damage are not available.

Earthquake in Japan, 21 June 1983

The earthquake was one of the many aftershocks and the strongest following the Japan Sea earthquake of 26 May, magnitude 7.8. This quake had a magnitude of 6.9 and its epicenter was located at 41.25°N and 139.26°E.

Tsunami warnings were issued for the west coasts of Honshu and Hokkaido. Waves measuring 9 cm and 14 cm were observed at Fukaura, north of Honshu and 28 cm at Esashi, south west of Hokkaido. No casualties were reported.

U.S. - Japan Tsunami Workshop Held

A workshop on tsunami was held in Tsukuba, Japan May 12-13, 1983. The purpose of the workshop was to promote interchange of ideas and research in progress between U.S. and Japanese scientists and engineers working in the field of tsunami. Participation was by invitation. There were a total of 26 participants and 5 observers from both countries. The topics discussed included the following:

A. Tsunami Behavior in Coastal Water and on Land

B. Nonlinear Problems of Tsunami

C. Mesh Consideration in Numerical Work

D. Finite Difference vs. Finite Element Methods

E. Tsunami Protective Measures in Japan and U.S.

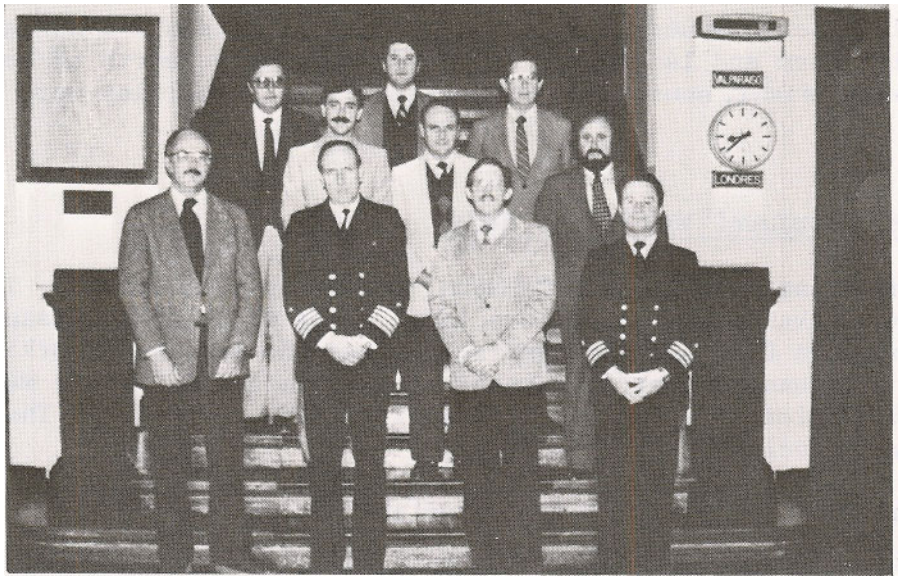
After the conference, the participants toured Kamaishi and Sendai. In Kamaishi, they visited the tsunami breakwater construction on the Sanriku Coast, an estimated 500 million dollar project. In Sendai, they went to Tohoku University to visit the laboratories of Professors Iwasaki and Shuto where on-going experiments were demonstrated to them.

THRUST Team Visits Chile

A team of scientists consisting of Dr. Eddie Bernard, Mr. Paul Krumpe, Mr. Richard Behn, Mr. James Lander, Mr. Peter McManonan and Dr. George Pararas-Carayannis, completed in early October a visit to Chile for the THRUST tsunami project in that country. THRUST is the acronym for a pilot program on Tsunami Hazard Reduction Utilizing System Technology.

The primary objective of the project is to develop, test, and evaluate an early tsunami warning system for a tsunami prone urban area. Valparaiso, Chile was chosen as the site for the THRUST project because it represents an urban area with high probability of tsunami occurrence.

The project is sponsored by the Office of U.S. Foreign Disaster Assistance of the Agency for International Development (OFDA) and it is envisioned as a three year project. The scope of work of the THRUST project entails the development of tsunami and earthquake data base, verification of a tsunami numerical model, preparation of hazard assessment maps for the coastline combining historical and modeling results, the establishment of seismic and tidal sensors using satellite telemetry to provide early warning information, and finally, the integration of the new early warning technology to existing local systems.



1st row (L-R) Mr. James Lander, Capt. Eduardo Barison Roberts, Mr. Paul Krumpe, Cmdr. Patricio Figueroa. 2nd row: Mr. Richard Behn, Mr. Emilio Lorca, Dr. George Pararas-Carayannis. 3rd row: Mr. Ariel Vera, Mr. Ricardo Rojas, Mr. Ricardo Montaner.

While in Chile, the team of scientists met with their Chilean counterparts on the project and planning and coordination meetings were held at the U.S. Embassy, at the University of Chile and at the National Emergency Office in Santiago. In Valparaiso, coordination meetings were held at the headquarters of the Chilean Tsunami Warning Center at the Navy Hydrographic Institute. The Hydrographic Institute is the lead agency in Chile responsib1ie for data collection and tsunami warning dissemination. Captain de Fragata, Eduardo Barison Roberts, the Institute's Director hosted the conference and members of his staff Mr. Ricardo Montaner, Mr. Alfonso Campusano, Mr. Emilio Lorca, Mr. Ricardo Rojas and Mr. Ariel Vera coordinated with the team the decisions of site selection data collection, telemetry and integration with the existing tsunami warning system in Chile.

In Santiago, the project was coordinated with the Director of the National Emergency Office, General Victor Lopez and his staff, and with the Director of the Department of Geophysics of the University of Chile, Dr. Edgar Kausel and his staff.

On the last day of the U.S. team's visit in Chile a press conference was given by the U.S. scientists and their Chilean counterparts on the proposed project and on the progress which was achieved during the visit. Ironically an earthquake of 7.4 on the Richter scale shook northern Chile and was distinctly noticeable in Santiago. Dr. Pararas-Carayannis who was talking to reporters at the time interrupted his presentation and smiling explained that the team had not programmed this particular earthquake and disclaimed any responsibility for it.

Krakatoa Remembered

1983 marks the 100th anniversary of the most famous volcanic eruption in recorded history. On August 26 and 27 of 1883 a huge explosion of 4 cubic miles of volcanic material from the Volcano of Krakatoa in the Sunda Strait between Java and Sumatra, generated a tsunami which killed more than 36,000 people on coastal villages. The phenomena associated with the eruption were observed or recorded around the world. The gigantic explosions from the eruption were heard as far as 3,000 miles away and the shock waves were recorded by barographs all over the world.

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ITSU-IX Planning Conference Held in Paris 8-12 August 1983

Mr. Gerry Dohler, Chairman of ITSU and Dr. George Pararas-Carayannis, Director of ITIC, were at the IOC Secretariat in Paris during the week of 8-12 August 1983 to work on the planning of the ITSU-IX Conference, and other related ITSU matters. Working sessions were held with Dr. Mario Ruivo, Dr. Iouri Oliounine, Dr. Kitazawa, Mr. Tregloss and other officials of IOC.

An annotated agenda for ITSU-IX was prepared as well as a list of supporting documents, to be distributed to national contacts of ITSU Member countries, in preparation for that conference in Honolulu, Hawaii on 13-18 March 1984. In addition to these documents, discussions were held on sea-level monitoring, instrumentation, telemetry, pending proposals for education and the enhancement of the Tsunami Warning System, training, and the ITIC visiting experts program.

Director ITIC, Attends U.S. Tsunami Coordination Conference

Dr. George Pararas-Carayannis, Director of ITIC attended the U.S. Tsunami Coordination Conference in Anchorage, Alaska on 13-15 September 1983 and presented a review of ITIC activities, as well as plans for the ITSU-IX meeting in Honolulu on 13-18 March 1984.

Director ITIC, Visits Chile

Director of ITIC, Dr. George Pararas-Carayannis, was in Chile from 26 September to 4 October, as a member of a six-person scientific team which visited the country to conduct a pilot study called THRUST (Tsunami Hazard Reduction Utilizing Systems Technology). The project has the support of the Office of U.S. Foreign Disaster Assistance (OFDA) and is carried out by the U.S. National Oceanic and Atmospheric Administration (NOAA). The project is discussed in greater detail in the "News Events" section of this Newsletter.

While in Chile, Dr. Pararas-Carayannis visited with the Navy Oceanographic Institute, the Chilean National Emergency Center and the Geophysical Institute of the University of Chile, and discussed problems of tsunami preparedness, data telemetry and communications with Chilean officials.

Director ITIC, Attends IUGG Conference in Hamburg, Germany

The Director of ITIC, Dr. George Pararas-Carayannis attended the IUGG Conference in Hamburg, Germany on 15-27 August 1983. In addition, he participated in the business meeting of the IUGG Tsunami Commission and represented the IOC Secretariat in the discussions proposing specifically that efforts should be made to hold concurrently the meetings of IUGG and those of ITSU so that an active dialog can be established between tsunami researchers and officials charged with the responsibilities for the operation of the tsunami warning program in their respective countries. It was resolved that the next scientific meeting of the IUGG Tsunami Commission be scheduled for Victoria B.C., Canada on August 5-10, 1985 following the ITSU-X meeting which is tentatively scheduled for July 29 - August 4, 1985.

Member of New Zealand Parliament Visits ITIC and PTWC

Mr. Ian McLean, Member of Parliament for Tarawera District and Member of the National Party of New Zealand was a visitor to ITIC and the Pacific Tsunami Warning Center (PTWC) in Honolulu, Hawaii in May of 1983. Mr. McLean's visit was sponsored by the U.S. Information Agency under the International Visitors Program. Mr. McLean is also the Chairman for the Public Expenditure Committee of the House of Representatives, Chairman of three Caucus Committees -- Economic, Forestry and Maori Affairs, and Member of Agriculture, Transport and Communications Government Committees. Because of his association with the above committees, some of which oversee activities of Civil Defense and disaster preparedness, Mr. McLean was particularly interested in tsunamis and the Pacific Tsunami Warning System.

Dr. George Pararas-Carayannis, Director of ITIC, briefed Mr. McLean on the International Tsunami Warning System and answered specific questions related to tsunami preparedness in New Zealand. Following these discussions, Mr. McLean was taken to the Pacific Tsunami Warning Center where he was familiarized with operational methodology of the Tsunami Warning System.

Ninth Session of the International Co-ordination Group for the Tsunami Warning System in the Pacific, Honolulu, Hawaii 13-17 March 1984

The following is the provisional summary agenda for the ITSU IX meeting. An annotated agenda will be published in the next issue of the Newsletter.

1. Opening of the Session

2. Administrative Arrangements for the Session

   2.1 Adoption of the Agenda
   2.2 Election of the Rapporteur
   2.3 Conduct of the Session, Timetable and Documentation

3. Intersessional Activities

   3.1 Reports of the Chairman of the Group and Director of ITIC on Intersessional Activities
   3.2 Discussion of National Inputs to the Improvement of the ITSU Network in the Pacific
   3.3 Review of the Effects of 26 May 1983 Tsunami in the Sea of Japan

4. Implementation of Actions Identified by the Eighth Session of ITSU

   4.1 Development of a Master Plan for International Tsunami Warning Operations (Res: ITSU-VIII.1)
   4.2 Additional Travel Time Charts (Res: ITSU-VIII.2)
   4.3 Establishment of Tsunami Warning Procedures (Res: ITSU-VIII.3)

5. Future Activities of the Group

   5.1 Communication Plan for the Tsunami Warning System
   5.2 Review of Recommendations and Resolutions from the IUGG Tsunami Commission Meeting in Hamburg, August 1983

6. Proposals to Enhance Training and Education of Tsunami Specialists of Developing Member States of the Region and Regional Co-operation

   6.1 Organization of Workshops on the Technical Aspects of Tsunami Analyses, Prediction and Communication
   6.2 Visiting Experts Training Programme
   6.3 Mission to Western Pacific Nations and UNDP Tsunami Project

7. Review of the Terms of Reference and Relationship of ITSU, ITIC and PTWC

8. Post of Associate Director of ITIC -- Status and Plans

9. Co-operation With Other International Bodies Involved in Tsunami Matters

10. Proposals for 1984-85 Draft Programme

11. Election of the Chairman and Vice-Chairman of the Group

12. Date and Place of Next Session

13. Adoption of Summary Report, Resolutions and Recommendations

14. Closure of the Session

Compilation of Data and Information for the Preparation of a Master Plan Completed

At the Eighth Session of ITSU held in Fiji last April, a resolution was passed for the development of a Master Plan for International Tsunami Warning System Operations. The Plan should provide all participants with the activities of the Group and an outline on how to utilize its resources for the improvement of the International Tsunami Warning System. The first compilation of data and information for the preparation of this Master Plan has been completed by Mr. Gerry Dohler, the Chairman of ITSU. It has been distributed to all national contacts as a working document for Agenda Item 4.1 of the ITSU-IX meeting to be held in Honolulu from March 13-17, 1984. This publication will provide a basis for discussion and formulation of the final version of the Plan.

List of National Contacts of ICG/ITSU

The following is a list of National Contacts of ITSU members on file in the ITIC office. Please inform ITIC if there are any changes.

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THAILAND

Commander Thanom Charoenlaph
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Royal Thai Navy
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UNITED KINGDOM (HONG KONG)

Mr. J. E. Peacock
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Kowloon, Hong Kong

USA	Mr. Richard H. Hagemeyer Director National Weather Service, Pacific Region P.O. Box 50027 Honolulu, Hawaii 96850
USSR	Mr. P. Agafonov Oceanographic Committee of the Soviet Union Gorky Street 11 Moscow 103009, USSR
WESTERN SAMOA	The Superintendent Apia Observatory Private Mail Bag Apia, Western Samoa
Director, ITIC	Dr. George Pararas-Carayannis Director International Tsunami Information Center P.O. Box 50027 Honolulu, Hawaii 96850 USA (Cable Address: ITIC HONOLULU)
Chairman, ICG/ITSU	Mr. Gerry C. Dohler Canadian Hydrographic Service Room 316, 615 Booth St. Ottawa, Ontario, K1A 0E6 Canada

ITIC Visiting Experts Training Programme

In order to improve the International Tsunami Warning System in the Pacific, a Visiting Experts Training Programme sponsored by the Intergovernmental Oceanographic Commission (IOC) and administered through its International Tsunami Information Center (ITIC) will be available to scientists and experts of ICG/ITSU Member States working in the field of Tsunamis (Recommendation ITSU-VIII.1).

The ITIC Visiting Experts Programme has a short-term training curriculum which will include the following:

1. A comprehensive coverage of the Tsunami Problem - generation, propagation, terminal effects, state of the art.

2. In-depth familiarization with the operational procedures of the Pacific Tsunami Warning Center (PTWC) in Honolulu.

3. Thorough coverage of the Pacific Tsunami Warning System and of Wave Reporting Procedures.

4. Training in tidal, seismic and communications instrumentation used by the Tsunami Warning System.

5. Training in regional Tsunami Warning System.

6. Familiarization with disaster preparedness and emergency procedures used by Civil Defense Agencies.

7. Simulated earthquake and Tsunami exercises.

8. Training on hardware automation, computer techniques, software development and risk analysis.

9. Training on post-disaster surveys.

10. Numerical modelling.

In addition, nominated scientists and experts participating in this training programme are expected to work on a specific task which will result in a tangible benefit to the Pacific Tsunami Warning System and to their country's Tsunami preparedness. Appropriate projects and tasks will be developed in close cooperation with the Director of ITIC and a final report of the work will be submitted to ITIC and to the IOC Secretariat.

The Intergovernmental Oceanographic Commission is planning to organize the training of one or two experts from the IOC/ITSU Member States in 1984 at the International Tsunami Information Center, Honolulu, Hawaii. The selection will be made jointly by the Director of ITIC and the IOC Secretariat. A similar opportunity will be extended in the next fiscal year to participants from other countries of the region.

Preference will be given to nominees from those countries which already participate actively or intend to participate in the Tsunami Warning System in the Pacific.

Participants will be required to have sufficient technical and geophysical ability to understand the details of both instrumentation and data analysis and modelling. They should be directly responsible for tidal seismic measurements or for supervising the national Tsunami warning system in the regional network and should have a good command of English which will be the working language of the training course.

Nominations of qualified persons and curriculum vitae should be sent to the IOC Secretariat with copies to the Director of ITIC. The closing date for the submission of nominations is 31 December 1983.

Seventeenth Session of the Executive Council of IOC

Participation is invited to the above mentioned session to be held from 31 January to 9 February 1984 at UNESCO Headquarters in Paris. Names and addresses of the participants should be submitted to the Secretary by January 10, 1984. For further information, contact: Dr. Mario Ruivo, Secretary IOC, UNESCO, 7 Place de Fontenoy, 75700 Paris, France.

Sea Level Pilot Project

The Integrated Global Ocean Services System (IGOSS) adopted in its third session of the IOC/WMO Joint Working Committee a draft operational plan for a Sea Level Pilot Project. The project is a part of an IOC initiative to develop a world-wide network of tide gauges comprised of existing national systems and where appropriate, supplemental instruments to be established on a regional basis. The project is expected to commence during 1983 and continue for five years. Over this period the project will provide, to begin with, monthly sea level data from participating tide stations located in the Pacific Basin with a timely delay of approximately two months. During the course of the project, additional products will be developed and the time delay will be decreased.

Eleventh Session of the IOC Working Committee on International Oceanographic Data Exchange (IODE-XI)

The above mentioned session will be held from 10 to 18 of January 1984 in New York at the United Nations Headquarters. The Agenda for this session will include among others Development of IODE Components; Requirements of IOC Science Programs and Ocean Services; Requirements of IOC Regional Subsidiary Bodies and Experiments; Future Role of Marine Information Management in IODE System and of the FAO/IOC/UN (OETB) Aquatic Sciences and Fisheries Information System (ASFIS).

Minutes of the Meeting of the IUGG Tsunami Commission August 19, 1983, Hamburg, Germany

The following minutes of the meeting of the IUGG Tsunami Commission were provided by Dr. Harold G. Loomis, its Secretary.

The meeting of the IUGG Tsunami Commission was called to order at 4:30 P.M., August 19, 1983 at Hamburg, Germany by Prof. H. Loomis, Secretary.

Present were: T.S. Murty, Canada, Vice-chairman; H.G. Loomis, USA, Secretary; W.M. Adams, USA; E.N. Bernard, USA; G.C. Dohler, Canada; K. Kajiura, Japan; H. Miyoshi, Japan; G. Pararas-Carayannis, USA.

Absent were: R.D. Braddock, Australia; V. Gusiakov, USSR; L.S. Hwang, USA; K. Iida, Japan, Chairman; T. Iwasaki, Japan; J.V. Presbitero, Philippines; R.O. Reid, USA; I. Ripper, New Guinea; R.P. Shaw, USA; E. Silgado, Peru; S.L. Soloviev, USSR; V. Sousa-Moreira, Portugal; W.G. VanDorn, USA; S.S. Voyt, USSR; R.A. Heath, New Zealand.

Telegrams have been received from R. Shaw, K. Iida, S.S. Voyt and S.L. Soloviev regretting their absence and expressing interest in remaining on the Commission. E. Silgado had earlier corresponded with the Secretary in an effort to get funds to attend and this letter is given the same interpretation.

The following members missed two meetings and have not requested to remain on the Commission: R.D. Braddock, Australia; R.A. Heath, New Zealand; J.V. Presbitero, Philippines; R.O. Reid, USA; I. Ripper, New Guinea; V. Sousa-Moreira, Portugal; W.G. VanDorn, USA, therefore the Secretary has been instructed to send them letters saying they will be dropped from the Commission unless they seriously want to remain on and have some hope of participating in future meetings and request reinstatement.

There followed an election of officers, and the results were:

Chairman:	T.S. Murty, Canada
Vice-Chairman:	H. Loomis, USA
Vice-Chairman:	K. Kajiura, Japan
Secretary:	E. Bernard, USA

The meeting was turned over to the new chairman. Items of business were:

1. There was some discussion of new members and suggestions for such were offered from the floor. However, it was pointed out that in Sendai, it was voted by the Commission to have the officers of the Commission propose new members to the Commission for approval. This will be done later, by mail. It was noted that it is really a matter for the members from each country to decide on the most appropriate membership for their own country and usually not a matter for an open discussion on the floor.

2. It was suggested that the position of Recording Secretary be added to the list of officers, and that the present position of Secretary become Corresponding Secretary. There was much discussion of this but a motion for a Recording Secretary died for lack of a second.

3. It was moved and seconded that the position of Treasurer be created. Much discussion followed about the need of such a position. It was pointed out that at present the Commission handles no money. The motion lost.

4. The next scientific meeting of the Commission is scheduled for Victoria, B.C., Canada on August 5-10, 1985. A five day meeting was challenged as being too long, but it was pointed out that at least two afternoon excursions are included in the program. The members agreed with the tentative plans for the meeting.

5. The ITSU meeting was scheduled on July 29 - August 4, 1985 to encourage exchange and interaction between the members of the two groups.

6. It was proposed that every scientific meeting of the Tsunami Commission should give rise to a proceeding. Much discussion of this followed. It was discussed whether this would consist of abstracts or prepared papers, how long, etc. It was agreed that only papers presented at the meeting would be included. Nothing was decided about length except that it be reasonable. Finally, it was moved, seconded and passed that each meeting should be covered by a proceeding.

7. A second proposal was that the Tsunami Commission declare itself the scientific arm of ITSU which is an international committee for tsunami warning system coordination. ITSU receives support from the IOC (Intergovernmental Oceanographic Commission, under UNESCO) and it was suggested that some of this support could be directed to the research community through such affiliation. Much discussion of this proposal followed. It was never clarified how a standing Commission of the IUGG could at the same time be a research arm of ITSU. The officers of the Commission were directed to talk with Prof. Melchior, Sec. General of the Union, for his impression of whether or not this was proper. In any case, the members of the Commission were strongly divided as to whether or not this was a good idea. The matter was left unresolved.

8. A motion was made to thank the Organizing Committee for providing mineral water, with and without gas, for the relief of the speakers. The motion passed, although I believe that as chairman of both sessions that day with the mineral water conveniently on the table in front of me, I was the only person to partake.

9. The meeting adjourned at 6:00 P.M., which indicates that some discussions were more lengthy than can be appreciated from these abbreviated notes.

The following are papers presented at the Tsunami Sessions of the IUGG Assembly:

10th SESSION IDS-08 (11.00-12.30) TSUNAMI A, Chairman: S.L. Soloviev

08/69 (L52) Diffusive Kinematic Waves Versus Hyperbolic Long Waves in Tsunami Propagation
- T.S. Murty

08/70 (L53) An Extension of Ball's Edge Wave Solution to Convex Upward Topographies
- R.P. Shaw, D. Paskausky

08/71 (L54) The Experiments on the Seiche
- H. Miyoshi

08/72 (L55) On Physical Interpretation of the Law of Tsunami Height Recurrence
- R.K. Mazova, E.N. Pelinovsky, A.A. Poplavsky

08/73 (L56) Seiches in Bays Forming a Coupled System
- M. Nakano, N. Fujimoto

08/74 (L57) Tsunami Flood Control at the Opening of a Bay
- S. Nakamura

08/75 (L58) Excitation Mechanisms of the 'Abiki' Phenomenon (A Kind of Seiche) in Nagasaki Bay
- T. Hibiya

11th SESSION IDS-08 (14.30-16.00) TSUNAMI B, Chairman: H.G. Loomis

08/76 (L59) Geographic Distribution of Tsunami Energy Along the Coast of Japan
- K. Iida

08/77 (L60) Reconsiderations on the Huge Tsunamis - Utility of the Seawall
- H. Miyoshi

08/78 (L61) A Feasibility Study on Mitigating Tsunami Hazards in the Pacific
- E.N. Bernard, G.T. Hebenstreit, J.F. Lander, P.F. Krumpe

08/79 (L62) A Two-parameter Scheme for Tsunami Zonation
- C.N. Go, V.M. Kaistrenko, K.V. Simonov

08/80 (L63) The Alaska Tsunami Warning Center's Automatic Earthquake Location Procedures
- T.J. Sokolowski, M.E. Blackford, G.W. Fuller, W.J. Jorgensen

08/81 (L64) A Preliminary Investigation of Tsunami Hazard
- C.C. Tung

12th SESSION IDS-08 (16.30-18.00) TSUNAMI C, Chairman: H. Miyoshi

08/82 (L65) Synthesis of Tsunami Wave Excitation by Normal Mode Summation
- S.N. Ward

08/83 (L66) Long Wave Observations near the Galapagos Islands
- E.N. Bernard, H.O. Mofjeld, H.B. Milburn, E.G. Wood

08/84 (L67) A Tsunami-resistant Tide Gauge for Epicentral Studies
- R. Bilham

08/85 (L68) The Nonlinear Response of a Tide Gauge to a Tsunami
- H.G. Loomis

08/86 (L70) Threshold Earthquake Magnitudes for Issuing Tsunami Alert at the Pacific Coast of the USSR
- C.N. Go, A.I. Ivashchenko, K.I. Nepop, S.L. Soloviev

08/87 (L71) Estimation of Tsunami Risk of a Near Earthquake from Observable Macroseismic Effect
- S.L. Soloviev, L.N. Poplavskaya

NATIONAL AND AREA REPORTS

U.S. Holds Tsunami Coordination Conference

The U.S. National Weather Service hosted a Tsunami Coordination Conference in Anchorage, Alaska on 13 to 15 September 1983. The Conference was attended by representatives of the Pacific Western and Alaska Regions of the National Weather Service, the Directors of the Pacific and Alaska Tsunami Warning Systems, representatives of the Pacific Marine Environmental Laboratory (PMEL), of National Ocean Survey (NOS), of the National Geophysical Data Center, and of the U.S. Geological Survey. Dr. George Pararas-Carayannis represented ITIC, Mr. Sydney O. Wigen of the Institute of Ocean Sciences, and National Tsunami Contact for Canada, also attended.

Issues discussed at the 1983 Tsunami Warning System Coordination Conference included the Communication Plan, Watch and Warning Procedures, data collection and automation, review of ITIC activities, satellite services, National Earthquake Information Services and Canadian tsunami activities.

Training Course on Tsunami Conducted in Chile

In an effort to improve the Chilean Tsunami Warning System, the Instituto Hidrografico de la Armada of Chile conducted a two month training course on Tsunamis in May and June of 1983. The purpose of the course was to familiarize participants with the theoretical and practical aspects of the tsunami warning system. Officers and personnel in charge of operations attended. During the course, the attendants visited the Santiago Seismological Station and the National Hydraulic Model Laboratory and obtained a practical understanding in the collection and analysis of seismic parameters and the modelling of tsunami effects in Valparaiso Harbor.

In the near future, a set of similar conferences and workshops are planned for other selected officials involved with natural disaster prevention and control. Participants to these conferences will be informed of the different aspects of tsunami generation, propagation, and effects as well as the operation of the Pacific and Chilean Tsunami Warning Systems.

SENA (Servicio Nacional de Aprendizaje) in Colombia

The above mentioned organization is a government agency in Colombia which was established in 1957 for manpower training and social development. As a result of the earthquake that almost destroyed a large portion of the City of Popayan, a "program of reconstruction" has been designed by this agency. The program includes organizations and technical training of the communities in self-help reconstruction, in masonry and related professions such as plumbing, electricity,

soldering, carpentry ... etc. Furthermore, the program also provides organizations and development of small and community enterprises, to activate the regional economy. As a part of the self-help reconstruction project, a newspaper entitled "EL AUTOCONSTRUCTOR" is published by SENA. For more information regarding this program, write to: Servicio Nacional de Aprendizaje, Apartado Aereo 623, Popayan, Colombia.

Tsunami Stations Inspection

The Pacific Tide Party personnel completed the inspection for the following stations:

Apia	8-9	March	1983
Yakutat, Alaska	5-6	June	"
Sitka, Alaska	19	June	"
Seward, Alaska	29	June	"
Kodiak, Alaska	1	July	"
Sand Point, Alaska	20	July	"
Unalaska, Alaska	22	July	"

ANNOUNCEMENTS

CALL FOR PAPERS -- Pacific Congress on Marine Technology

The Hawaii Section of the Marine Technology Society (MTS) will conduct a Pacific Congress on Marine Technology on 24-27 April 1984 at the Princess Kaiulani Hotel in Honolulu. The conference is designed to bring together scholars and resource persons who will address key issues concerning the marine technology related to the ocean economic potential of the region from a multi-disciplinary perspective.

The papers and discussions will address the economic, legal, political, defense and socio-cultural dimensions of Pacific Basin ocean resource development and management. Special attention will be paid to the impact of marine technology on the quality of life of the Pacific islanders. The presentation will combine theoretical insights and empirical research on problems of current and continuing interest to a broad audience. Sessions on the following topics are planned: Ocean Energy, Marine Recreation, Development Financing, Ocean Mining, Ocean Science and Engineering, Marine Transportation, Offshore Resource Management, Fisheries, Trade, Technology Transfer, Navigation and Positioning, Remote Sensing, and Tsunami Detection.

The Conference Committee is inviting papers for presentation at the Congress. Accepted papers will be considered for publication in the Proceedings. Please send title and abstract (about 400 words) as soon as

possible, to: PACON 84, Center for Engineering Research, University of Hawaii, Honolulu, Hawaii 96822. Authors of accepted papers will be notified by December 31, 1983. Full length papers will be due March 15, 1984.

Seismicity Map of Middle America Available from NGDC

A multicolor "Seismicity Map of Middle America" has been published by the National Geophysical Data Center (NGDC) and the National Earthquake Information Service (of the U.S. Geological Survey). The 41- by 35-inch map shows the locations of major earthquakes and many smaller events occurring in that region of the world from 1900 through 1979; it also includes important information about each major event in a table below the map. Earthquake locations are displayed on a Mercator projection at a scale of 1:8,000,000, which includes the area of the world from 5°S to 35°N and 55°W to 125°W.

The map may be purchased from NGDC for $5 (folded) or $10 (rolled) prepaid. In addition, the digital data used to produce the map may be purchased on magnetic tape for $150. There is a minimum charge of $10. Please specify 7- or 9- track mode and 556, 800, or 1,600 bpi density and either ASCII or EBCDIC character code conversion. Checks or money orders should be made payable to: COMMERCE/NESDIS/NGDC - National Geophysical Data Center, NOAA, Code E/GC1, 325 Broadway, Boulder, CO 80303 (USA).

Natural Hazards Photograph Catalog

The National Geophysical Data Center (NGDC) and World Data Center A for Solid Earth Geophysics have collected from many private and governmental sources more than 2,000 photographs of effects from natural hazards that have occurred throughout the world, including earthquakes, tsunamis, and volcanoes. The collection contains photographs of events that span two centuries (1811-1981) and cover more than 37 countries.

The publication gives a brief description (or caption) for each photograph in the collection and contains many examples of dramatic or unusual photographs. The photograph captions are listed chronologically by date of occurrence of each event (except for volcano captions, which are listed by region) and are grouped into three categories: 1) earthquake damage (1,064 photographs); 2) tsunami waves and damage (687 photographs); and 3) volcanoes and volcanic features (297 photographs). The section on Earthquake Damage also contains a list of miscellaneous photographs, which includes seismological instruments, storm-surges, isoseismal maps, and others.

Special Slide Sets - Included in the catalog are descriptions of three unique sets of 35-mm slides, which may be purchased separately from the main collection described above. These subsets of the main collection are the "Earthquake Damage Slide Set," "Tsunami Slide Set," and the

"Volcanoes in Eruption Slide Set." Each set contains 20 slides that represent the best photographic examples of the NGDC collection. These special sets provide a unique and affordable tool for presentation to both technical and nontechnical audiences.

To order your free copy of the catalog, please write to the following address: National Geophysical Data Center, NOAA, Mail Code E/GC1, 325 Broadway, Boulder, Colorado 80303, U.S.A.

Pacific Telecommunications Conference (PTC '84)

The sixth annual conference of the Pacific Telecommunications Council will be held January 8-11, 1984 at the Sheraton Waikiki Hotel in Honolulu. The Conference will continue to explore the ongoing theme of Telecommunications for Pacific Development. It will focus on basic telecommunication needs -- what they are, how they can be met, the resources available, the implications of the technology for the individual and society, and the problems related to developing an information-rich Pacific Hemisphere. Some 500 distinguished business people, government officials and educators are expected to attend. Among these will be people from the Pacific Hemisphere as well as individuals from other parts of the world with interests in the Pacific. On the programs, there will be a number of high level keynote speakers as well as in-depth studies of telecommunications in the Pacific Region. In addition to paper and response sessions, the conference will have two afternoons devoted to study groups, looking for concensus on major telecommunication issues. Another afternoon will be given over to small working groups interacting in a wide variety of specific subjects.

ABSTRACTS

Numerical Tsunami Model in Osaka Bay

Shigehisa Nakamura

A numerical experiment was undertaken to find what combination of tsunami source parameters was reasonable for an understanding of the dynamics of a tsunami inundating into a bay. Finite difference method was applied to the basic equations of long waves. The modelled area included Osaka Bay, Kii Channel, Harimanada and a part of the northwestern Pacific Ocean. In addition, the arrival time of the leading wave is discussed in reference to the results of the numerical experiment. The numerical results compare reasonably well with those from an observed tsunami.

[Bull. Disas. Prev. Res. Inst., Kyoto Univ., Vol. 33, Part 1, No. 295, March 1983]

Local Probability of Maximum Wave Height

Shigehisa Nakamura

Maximum wave height was studied with an assumption of Poisson process to obtain a local probability of its appearance. The concept of the local probability was already introduced by NAKAMURA (1981) in a study of invasive tsunami. A modified Poisson process was considered to find a good fit to the observed result. As a specific application, a case study was undertaken for maximum wave height at Susami, the south of Japan, in order to obtain local parameters which characterize the yearly or monthly maximum wave height. Additional remark is a way to consider the wave period in the analysis.

[Text in Japanese. La mer 21: 1-6, 1983, Societe Franco-Japonaise d'Oceanographie, Tokyo]

1883 Krakatoa Tsunami in a Scope of Numerical Experiment

Shigehisa Nakamura

1883 Krakatoa tsunami around the Sunda Strait was studied by using a simple numerical model for finite difference method. The author tried to find properties of tsunami front, arrival time and tsunami height on the basis of the numerical experiment. Estimated value of the wave energy trapped in the Sunda Strait was about 54% of initial increase of an equivalent potential energy at the tsunami source area being due to a vertical displacement of the water surface. This result seems to be successfully applicable to a tsunami in a strait or channel of similar dimension, e.g. the Kii Channel in Japan.

[Text in Japanese. La mer 20: 29-36, 1982. Societe Franco-Japonaise d'Oceanographie, Tokyo]

Maremotos en La Costa de Chile

Published by the Instituto Hidrografico de la Armada of Chile, I.H.A. Pub. 3016, 1st edition, 1982.

This publication provides information on the generation, propagation and effects of several major tsunamis that have reached the Chilean coast in the past.

[Text in Spanish]

Local Long-Term Prediction of Tsunami and Tsunami Zoning

Ch. N. Go, V. M. Kaistrenko, and K. V. Simonov

[Text in Russian] Abstract in original language not included here.

PACIFIC TSUNAMI WARNING CENTER

Seismic Summary (May 1, 1983 to Press Time)

EVENT NO.	EVENT	LOCATION	ACTION TAKEN
1983-6	May 26 0300 (UT)	Sea of Japan 40.5 N	Earthquake Investigation, and Investigation Closed Bulletin issued.
(PTWC)	7.7	139.0 E	
1983-7	Jun 21 0626 (UT)	Sea of Japan 41.2 N	Earthquake Investigation, and Investigation Closed Bulletin issued.
(PTWC)	6.9	139.2 E	
1983-8	Jun 24 0907 (UT)	Taiwan 24.5 N	Earthquake Bulletin issued.
(PTWC)	6.5	122.6 E	
1983-9	Jul 11 1256 (UT)	South Sandwich Islands 58.9 S	No Earthquake Information Bulletin issued.
(PTWC)	6.9	21.7 W	
1983-10	Aug 6 1544 (UT)	Northern Greece 40.0 N	No Earthquake Information Bulletin issued.
(PTWC)	7.0	25.0 E	
1983-11	Aug 17 1056 (UT)	Kamchatka Peninsula 55.9 N	Earthquake Information Bulletin issued.
(PTWC)	6.8	160.9 E	
1983-12	Oct 4 1852 (UT)	South of Antofagasta, Chile 25.9 S	Earthquake Information Bulletin issued.
(PTWC)	7.4	70.0 W	
1983-13	Oct 15 1057 (UT)	Solomon Islands 7.8 S	Earthquake Information Bulletin issued.
(PTWC)	6.7	156.5 W	
1983-14	Oct 28 1406 (UT)	Central Idaho 44.1 N	No Earthquake Information Bulletin issued.
(PTWC)	6.9	113.7 W	
1983-15	Oct 30 1413 (UT)	Eastern Turkey 40.9 N	No Earthquake Information Bulletin issued.
(PTWC)	6.9	42.4 E	

SPECIAL REPORT

THE NIHONKAI CHUBU EARTHQUAKE TSUNAMI

by
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At 0:00 p.m. on May 26, 1983 in Japan Standard Time, an earthquake of M = 7.7 occurred in the Japan Sea. The epicenter determined by OCEP (Observation Center for Earthquake Prediction, Tohoku University) was located 15 km below the sea bottom at 40.41° N and 139.08° E, about 80 km off Akita Prefecture, northern part of Honshu Island. Other parameters of this thrust fault are: the direction of fault = from south to north, the dip angle = 22° - 30° inclined to east, the area of fault = 30 km x 100 km, and the displacement = 4 m - 5 m [K. Shimazaki and J. Mori].

Before 0:14 p.m. when the tsunami warning was issued, the first wave had been observed at several places. It hit the Oga Peninsula at 0:08 p.m. and claimed lives of thirteen pupils on excursion on a beach.

Around 0:25 p.m., the northern coast of Akita Prefecture (hereafter called the North Akita Coast) was attacked by the second wave. It had the greatest height in the sea but did not always yield the greatest run-up height. At the construction site of Noshiro Harbour near the center of the North Akita Coast with a sandy, smooth shoreline 55 km long, many workers were caught by the tsunami and drowned. The second wave observed here had two or three waves of short period at its front. The height of these waves was said between six and eight meters and their wave length was of the order of 100 m, although the tide gauge in the harbour recorded the rise of sea water level of only 2.09 m and a half wave period of 5 min.

Since then, the tsunami repeatedly attacked the coast. Around 1:30 p.m., the first wave arrived at the eastern coast of Korea. At 8:58 p.m., the tsunami warning was all cleared.

Figure 1 shows the area of tsunami source determined by T. Hatori. Dotted (solid) lines mean the tsunami began with fall (rise) at the observation points. Numerals attached give the travel time of the first wave in min. The tsunami source area coincides with and covers the aftershock area determined by OCEP as shown in Fig. 2, in which the star is the epicenter and small circles are the position of aftershock since May 26 to May 31.

Measured run-up heights are shown in Fig. 3. Large run-up heights are observed on the sandy North Akita Coast with the maximum, more then 14 m, on a dune in the village of Minehama.

Breakwaters of small fishing harbours seemed to work effectively. Traces of the tsunami inside and outside harbours are shown by dotted and solid lines in Fig. 4 obtained by the Ministry of Transport. For example, at Tsubaki Fishing Harbour where the water area of 7 000 m^2 is surrounded by breakwaters about 4.5m high with an opening 20 m wide, the traces inside the harbour are more than 5 m lower than the maximum run-up outside the harbour.

The day was a fine day with a clear sky. There were neither wind nor wind waves nor swells. Photos and videos were taken by many people. Photo 1 shows the first wave observed at the northern side of the Oga Peninsula, which is located at the southern end of the North Akita Coast. Five photos in sequence show the development and breaking of waves of short period at the front of the first wave. The same scene were taken, at a place about 3 km east of the place of Photo 1, in a video tape, on which it was observed that the tsunami grew to have four breaking waves of short period, followed by two or three non-breaking waves. The height and length of these waves of short period are estimated to be 3 m - 4 m and 150 m respectively, compared with the size of a floating fishing boat in a picture. Reflection of these waves, a train of nonbreaking waves of short period, was photographed by another person (Photo 2).

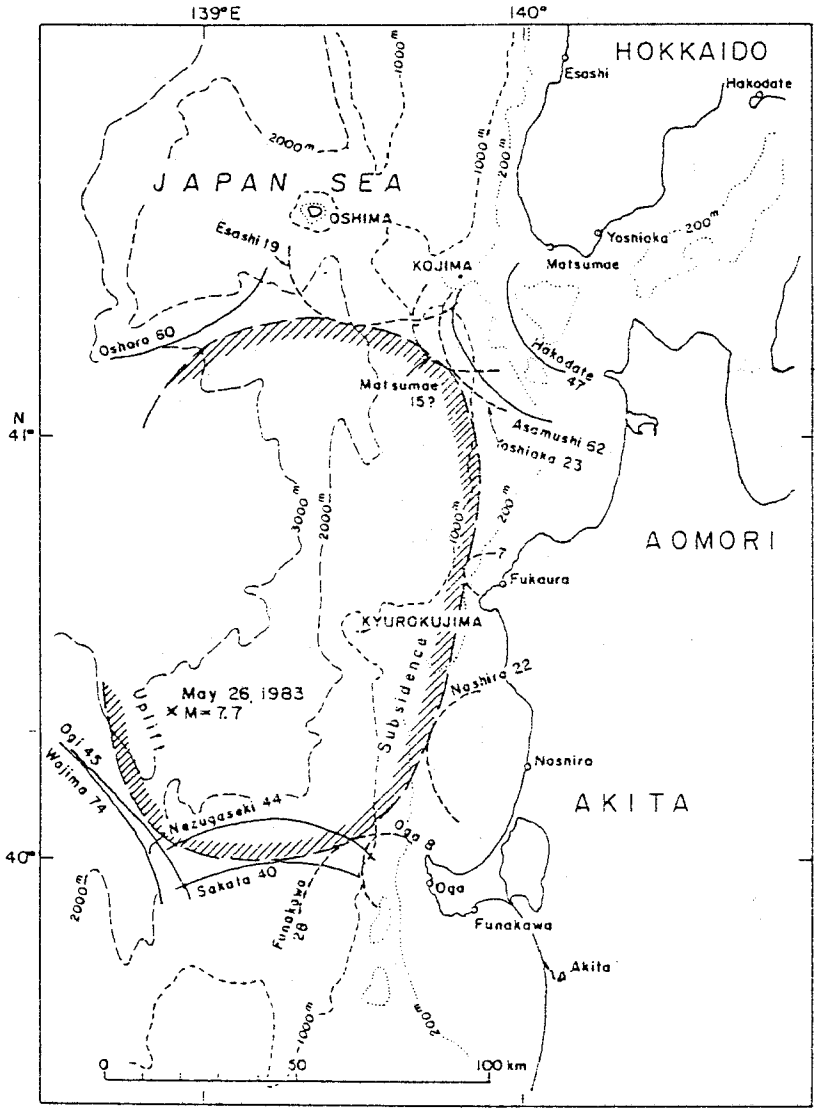
However, the first wave observed at the northern part of the North Akita Coast had only one steep wave crest, which broke before running-up the beach. Photo 3 shows the fourth or fifth wave attacking the northern end of the North Akita Coast. An edge bore propagates along the coast from south to north.

Except for along the North Akita Coast and its vicinity, the tsunami showed normal behaviors as waves of long period of about ten minutes.

The sandy beach of the North Akita Coast where large run-ups were observed is fortunately sparsely populated. In its vicinity where the average run-up height was of the order of 5 m - 6 m, only a few houses on low land were inundated and some of them were destroyed or washed away.

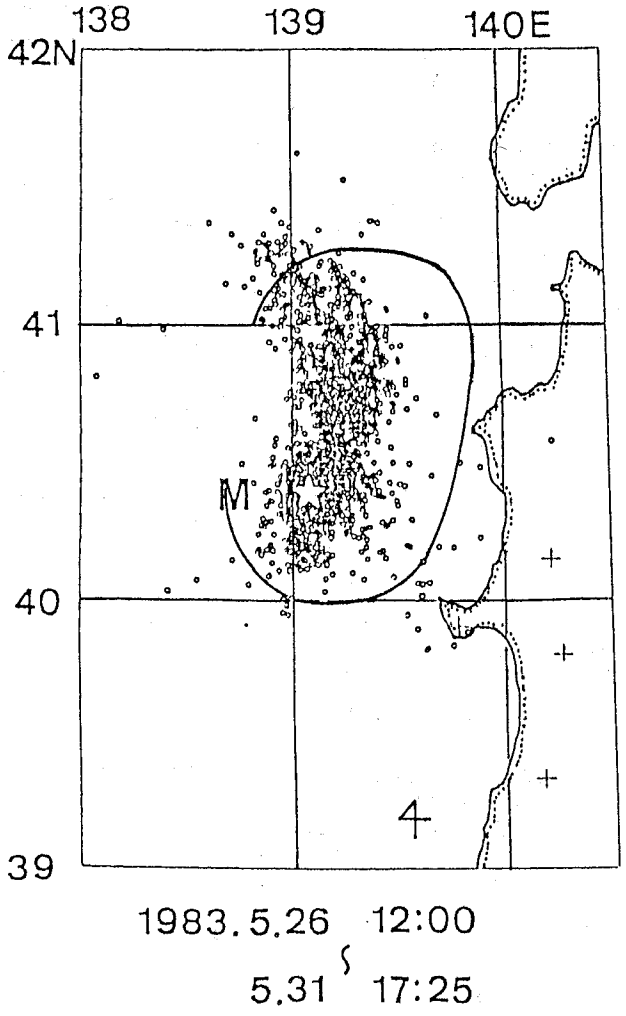
In total one hundred persons were lost due to the tsunami: 40 workers in harbour construction works, 18 persons in fishing for leisure on rocky beach, 17 tourists and pupils on excursion, 11 fishermen on beach, 8 persons due to capsizal of fishing boat, 5 farmers on the paddy field inundated by the tsunami and 1 patrolman watching the tsunami.

A great deal of damage was done to fishing boats and fishing gears such as set-net, gill-net and buoy.



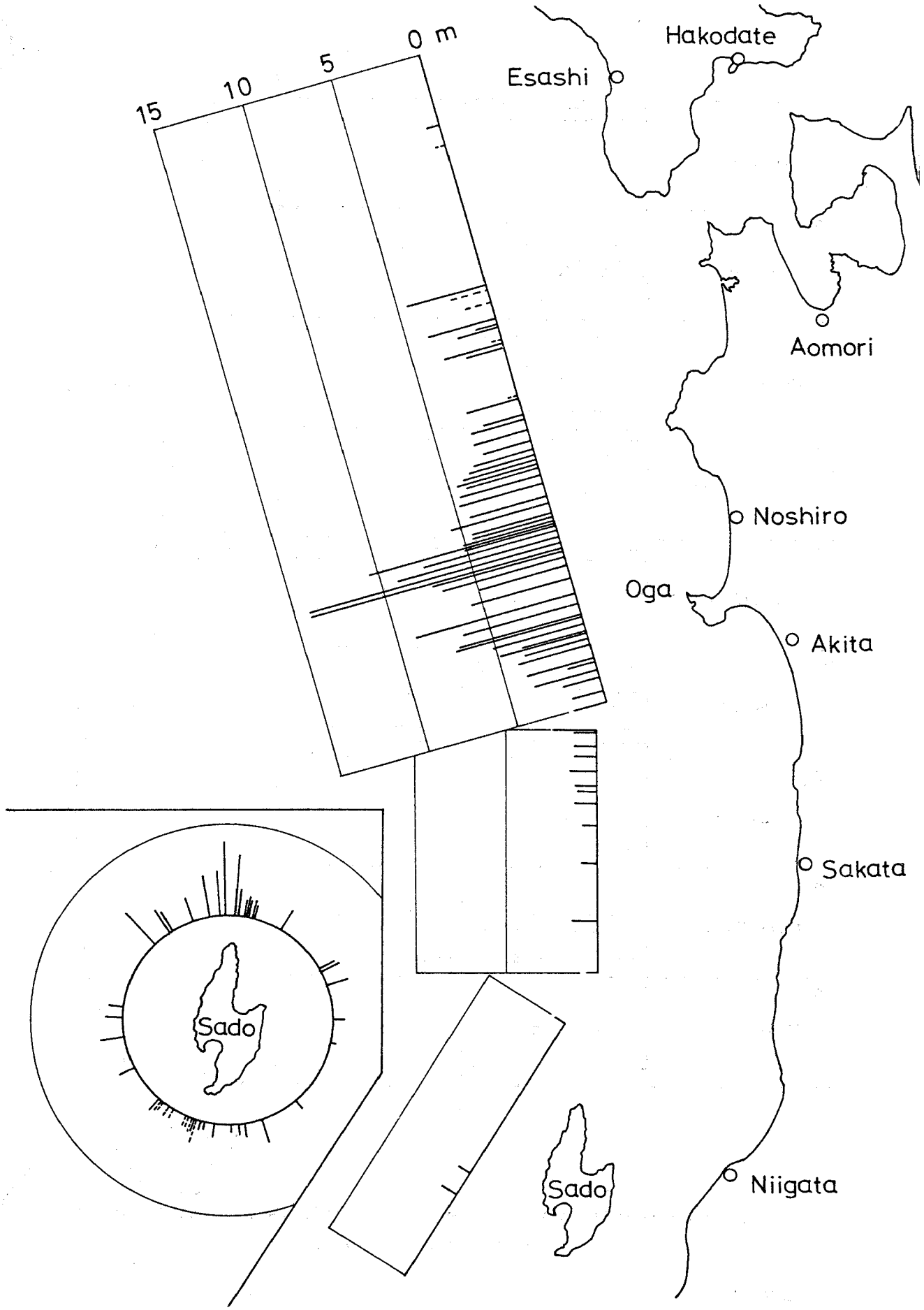
Tsunami Source Area (T. Hatori)

Figure 1



Aftershock Area and Tsunami Source Area
(OCEP and T. Hatori)

Figure 2



Run-up Height (Research Group Supported by the Ministry of Education, Science and Culture, and Penta-Ocean Construction Co.)

Figure 3

The First Wave Observed at the Tip of the Oga Peninsula

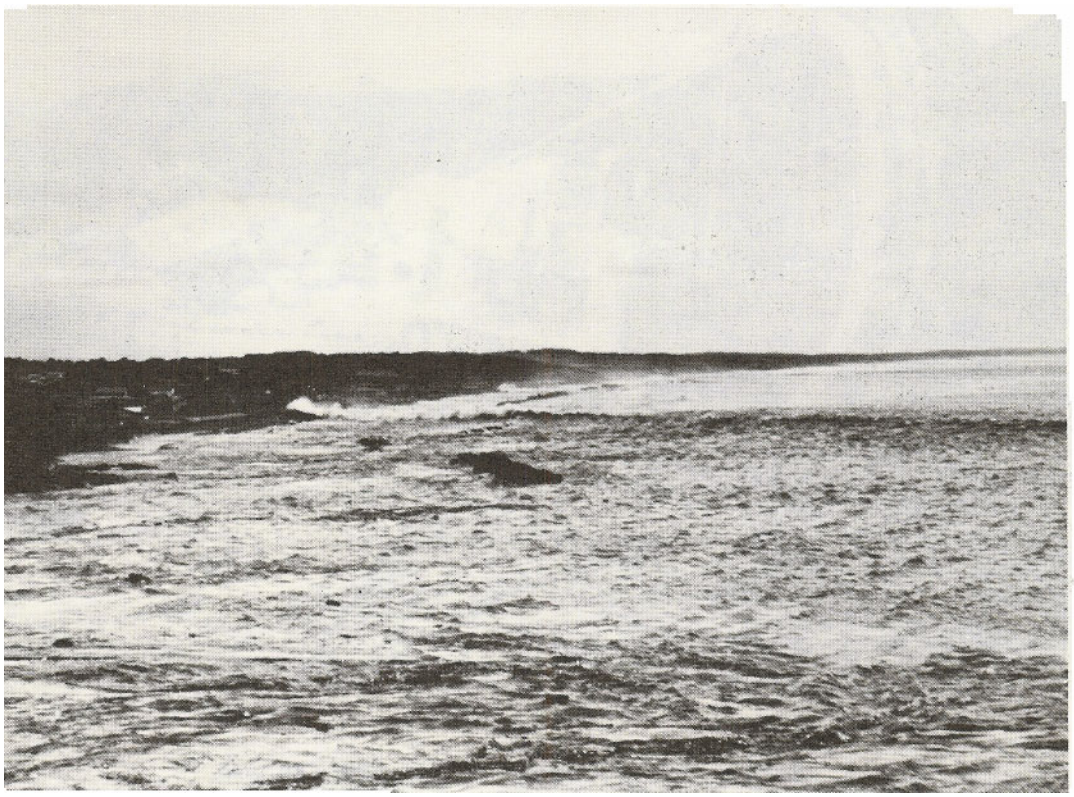
(Photograph by T. Seki)

Photo 1

Reflection of the First Wave and the Incident Second Wave

(Photograph by N. Oba)

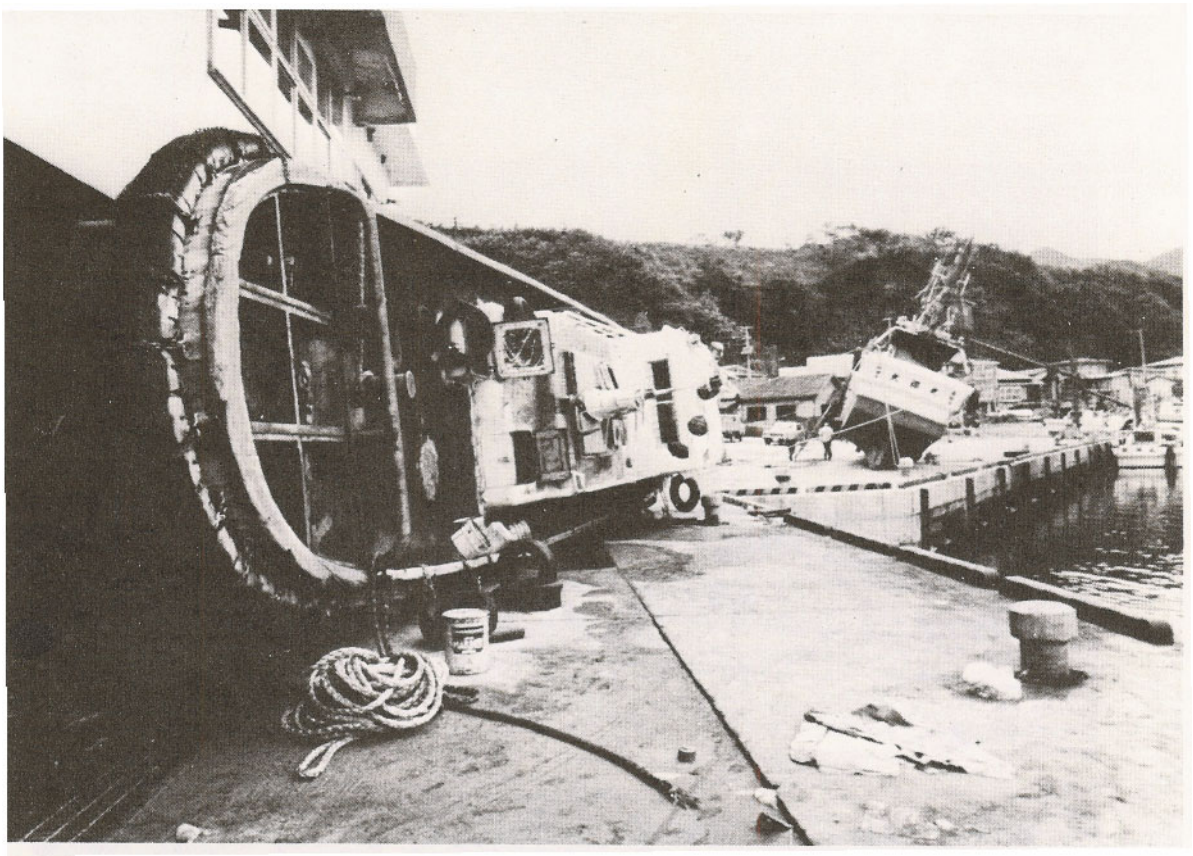
Photo 2



An Edge Bore Observed at the Northern End of the Akita Coast

(Photograph by TK. Yamanouchi)

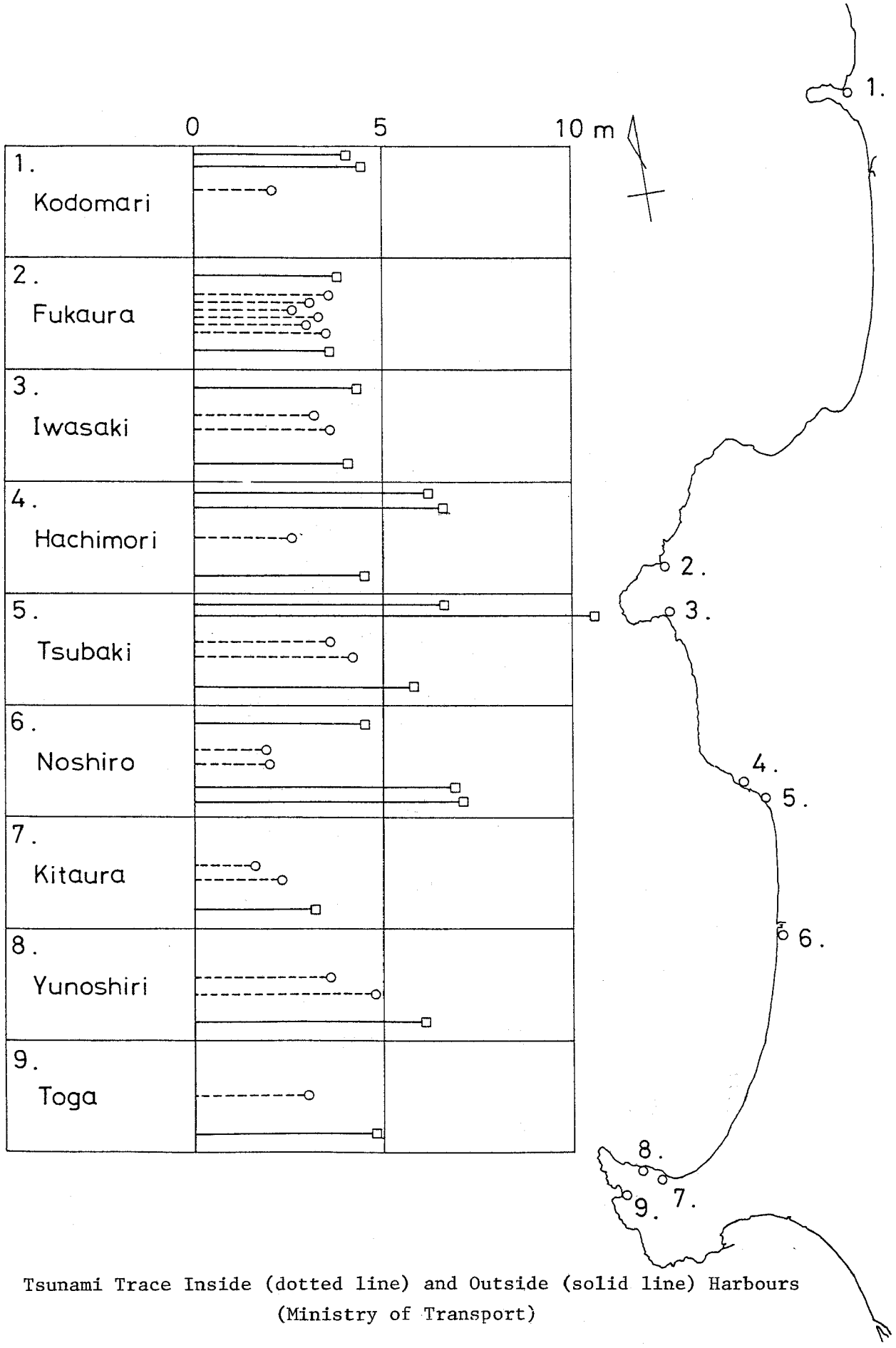
Photo 3



Fishing Boats Thrown Up by the Tsunami

(Copyright photo by the Kahoku Shinpo)

Photo 4



Tsunami Trace Inside (dotted line) and Outside (solid line) Harbours
(Ministry of Transport)

Figure 4

Merry Christmas

and

Happy New Year